

CHAPTER H

Bridges

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H.01 Introduction

H.01.01 Chapter Content and Resources

This chapter contains information relevant to the maintenance of bridge structures (including groups of closely spaced pipes) and special structures such as seal slabs that are identified by bridge numbers assigned by Structure Maintenance and Investigations (SM&I) and listed in the State Bridge Log. Work performed on these structures, other than pumping plants, will be under the HM3 program of the “H” Family of the Maintenance Program. Work performed on pumping plant structures will be under the HM251 program of the “H” Family of the Maintenance Program.

The maintenance of Reinforced Concrete Box (RCB) culverts and pipe culverts measuring 20 feet or less between abutments, and not assigned a bridge number by SM&I, are covered in Volume 1, Chapter C5, of the Maintenance Manual. Work on these structures is included in the HM2 Roadside Program.

Bridge maintenance includes, but is not limited to, work such as repairing damage or deterioration of various bridge components, removing debris from piers, performing minor scour repairs, cleaning, and repairing bridge bearing seats, abutments, etc., cleaning out drains, repairing expansion joints, cleaning, and painting structural steel, and sealing concrete surfaces. Also included are the maintenance of electrical and mechanical equipment on moveable span bridges, and the operation of the moveable spans.

Refer to Volume 2 of the Maintenance Manual for planning, scheduling, and administrative procedures connected with the HM3 program of the “H” Family.

This chapter provides an overview of policies, expectations, and strategies regarding bridges. For references found within this chapter, refer to the following resources:

American Association of State Highway and Transportation Officials Manual for Bridge Evaluation: [AASHTO Manual for Bridge Evaluation | Structure Maintenance And Investigations \(ca.gov\)](#)

Bridge Crew Resource Center (BIRIS and Bridge Level of Service): [Bridge Crew Resource Center | Structure Maintenance And Investigations \(ca.gov\)](#)

Bridge Damage Memos: [Reporting Bridge Damage Memos | Structure Maintenance And Investigations \(ca.gov\)](#)

Bridge Mapping Tool - BView: <https://svgcsmiapp.dot.ca.gov/bview/>

California Code of Regulations: [California Code of Regulations - California Code of Regulations \(westlaw.com\)](#)

Caltrans Electronic Forms System (CEFS): [CEFS - Forms \(ca.gov\)](#)

First Responder Bridge Assessment Guide (FRBAG);

<https://smi.onramp.dot.ca.gov/downloads/smi/files/Manuals/First%20Responder%20Bridge%20Assessment%20Guide.pdf>

California Manual on Uniform Traffic Control Devices (CA MUTCD): [CA MUTCD Files | Caltrans](#)

Standard Specifications: [Standard Plans, Standard Specifications and Contract Item Codes | Caltrans](#)

Street and Highways Code (SHC): [Codes: Codes Tree - Streets and Highways Code - SHC \(ca.gov\)](#)

Structure Maintenance and Investigations (SM&I) Contacts: [Bridge Contacts | Structure Maintenance And Investigations \(ca.gov\)](#)

Structure Maintenance and Investigations (SM&I) Website: [Structure Maintenance & Investigations | Structure Maintenance And Investigations \(ca.gov\)](#)

Structure Maintenance and Investigations (SM&I) Procedures Manual: [SM&I Procedures Manual | Structure Maintenance And Investigations \(ca.gov\)](#)

Traffic Operations Program: [Traffic Operations | Caltrans](#)

Vehicle Code (VEH): [Codes: Codes Tree - Vehicle Code - VEH \(ca.gov\)](#)

Vertical Clearance Sign Policy Memorandum: [Bridge Crew Manuals | Structure Maintenance And Investigations \(ca.gov\)](#)

H.01.02 Acronyms and Definitions

Acronyms

| | |
|--------|--|
| AASHTO | American Association of State Highway and Transportation Officials |
| ABME | Area Bridge Maintenance Engineer (SM&I) |
| AC | Asphalt Concrete |
| ASR | Alkali-Silica Reactivity |
| ASTM | American Society for Testing and Materials |
| BIRIS | Bridge Inspection Records Information System |
| CEFS | Caltrans Electronic Forms System |
| DF | Douglas Fir |
| E-FIS | Enterprise Resource Planning Financial Infrastructure |
| FHWA | Federal Highway Administration |
| HM | Highway Maintenance |
| HMWM | High Molecular Weight Methacrylate |
| MUTCD | Manual on Uniform Traffic Control Devices |
| EMWW | Office of Electrical, Mechanical, Water and Wastewater Engineering |
| PS&E | Plans, Specifications and Estimate |

| | |
|------|---|
| RCB | Reinforced Concrete Box |
| RW | Redwood |
| SM&I | Structure Maintenance and Investigations |
| SNOW | Service Now (Information Technology Service Portal) |

Definitions

Maintenance describes work that is performed to maintain the condition of a bridge or structure, to respond to specific conditions or events, and/or that restores the structure to a functional state of operations. Maintenance is a critical component of a Caltrans asset management plan that includes both routine and preventive maintenance.

Must – 1: an imperative need REQUIREMENT
2: an indispensable item: ESSENTIAL

Routine maintenance encompasses maintenance work that is performed in reaction to an event, season, or activities that are done for short-term operational need that do not have preservation value. This work requires regular recurring attention.

Preventive maintenance encompasses bridge preservation actions or strategies prevent, delay, or reduce deterioration of bridges or bridge elements; restore the function of existing bridges, keep bridges in good or fair condition, and extend their service life.

Should – indicating a desirable or expected state.

H.01.03 References and Hyperlinks

There are hyperlinked resource materials identified within this chapter. If any hyperlink is not accessible, please notify the appropriate personnel to inquire about that resource or reference.

H.01.04 Chapter Contact

This chapter of the Maintenance Manual is maintained by the Division of Maintenance, Office of Structure Maintenance and Investigations (SM&I).

H.02 Preventive Maintenance and Preservation

Bridge preservation actions or strategies prevent, delay, or reduce deterioration of bridges or bridge elements; restore the function of existing bridges, keep bridges in good or fair condition, and extend their service life. Preservation actions may be done in time cycles or be condition driven.

Examples of work items may be removal of debris in joints/bearings, clearing debris from fenders in waterways, clearing deck drains, and maintaining water runoff from storms that can cause erosion of the embankments. Other related items can be found in Section H.06 of this chapter. The Office of SM&I can assist with detailed structure preservation items per location or route.

Under the direction and with support of the Region Maintenance Manager II, the Bridge Maintenance Supervisors are responsible to perform routine and bridge preventive maintenance on the bridges in their area.

Maintenance Levels

Bridge maintenance work can be grouped into two categories: work initiated by the district, and work recommended in Bridge Inspection Reports.

Work initiated by districts can be maintenance or preservation items or directly in response to a problem on a bridge that affects public safety or the structural integrity of the structure.

Work recommendations in Bridge Inspection Reports are the result of periodic engineering inspections performed by Area Bridge Maintenance Engineers (ABMEs) or Specialty Investigation staff from SM&I. This work can generally be accomplished on a planned basis. However, when the work is of a critical nature, the ABME will immediately contact the district and verbally transmit instructions regarding the work required. This will be followed by a Bridge Inspection Report covering the work recommended.

When work recommendations are made, the recommendations will suggest the work be done either by contract or by maintenance crews. These recommendations are for guidance and the district has the flexibility to accomplish the work by any means available. However, it should be noted that many of the repair recommendations affect structural components and are engineered solutions, therefore the repair recommendations, methods, and procedures must be closely adhered to.

Because structural considerations are involved, changes or deviations must only be made with the concurrence of the ABME.

Descriptions of major or minor defects are listed in the following sections of this chapter.

H.03 Inspections by Area Bridge Maintenance Engineers (ABMEs)

To comply with federal regulations, all bridge structures (as defined in Section H.06 of this chapter) must be inspected by SM&I ABMEs, typically at a 24-month inspection interval and more frequently when the need is determined by the ABME. Some bridges also receive Nonredundant Steel Tension Member (NSTM), Special Feature Steel, Complex, Underwater, and Hydraulic inspections. As part of the inspection, an engineering evaluation is made regarding the condition of all structural, mechanical, and electrical components. Work recommendations are made for any corrective actions required.

Often, the ABME will require assistance from the district crews to perform the bridge inspections in the form of lane closures, special access equipment, obtaining material samples, encampment removal, etc. Bridge crews must provide inspection support to the SM&I upon request. SM&I will provide reasonable notice for this request except for unforeseen events that require immediate assistance.

A summary of all completed Bridge Inspections is forwarded monthly to the Deputy District Director of Maintenance, who is responsible for scheduling and accomplishing the work

recommendations in a timely manner. Copies of the Bridge Inspection Reports can be viewed through the SM&I website, referenced in Section [H.01.01](#) of this chapter, as well as by using the Bridge Crew Resource Center hyperlink.

A “live” list of outstanding work recommendations can be viewed by visiting the Bridge Crew Resource Center website under Work Rec’s. When work is completed by District forces, the work must be marked as completed through the bridge mapping tool BView. SM&I staff should be contacted, through the SM&I email askbam@dot.ca.gov, if assistance is needed in marking work complete.

Each work recommendation is identified by action type, structure target time frame, and accompanied by an estimated cost to do the work. Structure target time frames are defined as follows:

- 1) Emergency – Emergency work recommendations are typically immediate actions to mitigate a deficiency to maintain the safety of the traveling public or stability of the structure, including repairs, operations restrictions, or possible structure closure.
- 2) Priority – Priority work recommendations typically consist of maintenance actions to mitigate conditions that impact the strength and serviceability of a bridge element, where those conditions do not pose an immediate safety risk to the traveling public or affect the stability of the structure. Priority work recommendations should be programmed for completion at the first practical opportunity and must not be deferred.
- 3) Routine – Routine work recommendations consist of preventive and corrective maintenance actions to preserve the structure and minimize future needs by restoring it to satisfactory operational condition based on common preventative maintenance practices. Most work recommendations generated by SM&I are routine in nature.

A monthly summary of all bridge work recommendations is forwarded monthly to the Deputy District Director of Maintenance and District Program Advisor.

Bridge work recommendations can have a variety of crews who are responsible to perform various work that is labeled as “Bridge Crew” or “District.”

This includes crews other than bridge crews, such as maintenance, landscape, guardrail, tree, and various others. Each Region’s Maintenance Manager II is responsible to review, assign, and ensure completion of recommendations for the Maintenance Manager II’s regions of responsibility.

Work recommendations should be completed in a timely manner based on the priority assigned by the ABME.

If any issues or conflicts arise causing the work to be left uncompleted, the Maintenance Manager II or designee must contact the ABME and District HM3 coordinator to discuss the need for further assistance or appropriate reassignments for each recommendation.

Work Recommendations are organized by each district and distributed by way of monthly Outlook emails groups (shown below).

A SNOW ticket must be created requesting to be added to the appropriate district email group. If you need further assistance, you can also send an email to askbam@dot.ca.gov.

DOT SMI Dist 01 Bridge Group SMI.Dist.1.Bridge.Group@dot.ca.gov;
DOT SMI Dist 02 Bridge Group SMI.Dist.2.Bridge.Group@dot.ca.gov;
DOT SMI Dist 03 Bridge Group SMI.Dist.3.Bridge.Group@dot.ca.gov;
DOT SMI Dist 04 Bridge Group SMI.Dist.4.Bridge.Group@dot.ca.gov;
DOT SMI Dist 05 Bridge Group SMI.Dist.5.Bridge.Group@dot.ca.gov;
DOT SMI Dist 06 Bridge Group SMI.Dist.6.Bridge.Group@dot.ca.gov;
DOT SMI Dist 07 Bridge Group SMI.Dist.7.Bridge.Group@dot.ca.gov;
DOT SMI Dist 08 Bridge Group SMI.Dist.8.Bridge.Group@dot.ca.gov;
DOT SMI Dist 09 Bridge Group SMI.Dist.9.Bridge.Group@dot.ca.gov;
DOT SMI Dist 10 Bridge Group SMI.Dist.10.Bridge.Group@dot.ca.gov;
DOT SMI Dist 11 Bridge Group SMI.Dist.11.Bridge.Group@dot.ca.gov;
DOT SMI Dist 12 Bridge Group SMI.Dist.12.Bridge.Group@dot.ca.gov

Work recommendations frequently contain recommendations that the work be done by contract. However, the districts may elect to do the work with their own forces, provided that the work is within statutory and policy limitations on work by Maintenance forces.

When work is to be done by HM3 Bridge Maintenance Contract, SM&I will prepare the PS&E, except for traffic handling, upon the issuance of an E-FIS Project Code by the district. Scheduling of projects will be a joint effort between SM&I and the district.

H.04 Inspections by District Maintenance Supervisors

Periodic walk-through inspections should be made by District Maintenance Supervisors to detect obvious defects, hazards, or potential problems, and to monitor known problems. The purpose of these inspections is to supplement the more detailed, but less frequent, inspections by the ABME. Special attention should be given to any condition that affects the safety and/or structural capacity of the bridge. Contact the assigned ABME if there is a question as to the structural condition.

When major defects or hazards are found, they must be immediately reported to SM&I and the ABME by telephone. The ABME is the primary contact. However, if contact with the ABME cannot be made, call the listed Area Bridge Senior and/or SM&I Office Chief. SM&I and ABME contact information can be found by clicking this link: [Reporting Bridge Damage Memos | Structure Maintenance And Investigations \(ca.gov\)](#)

If an emergency condition exists, appropriate action must be taken immediately to maintain the safety of the traveling public and to prevent further structural damage from occurring. This includes, but is not limited to, restricting traffic on the bridge or closing it completely, installing temporary support systems, or making temporary repairs. After a major storm, fire, earthquake, or other natural event that may cause damage to bridges, Maintenance supervisors should inspect all bridges in the affected area for signs of damage. Any damage found should be reported to SM&I. SM&I will immediately send out an ABME to evaluate the condition of the structure and direct necessary repairs.

When responding to any bridge damage, bridge crews or equivalent crews are designated first responders. These crews should respond to such incidents by first identifying the bridge name, number, location, and nature of damage, then relaying this information to SM&I. Crews will assist in the first steps of a coordinated response led by SM&I.

The First Responder Bridge Assessment Guide (referenced in Section [H.01.01](#) of this chapter) was developed for the use by Caltrans maintenance crews to accurately report bridge damage information to SM&I and to make decisions to close or restrict bridges.

Refer to the Bridge Damage Memos (referenced in Section [H.01.01](#) of this chapter) in your respective district for a detailed protocol and callout list of ABMEs, Area Seniors, and Office Chiefs. SM&I and ABME contact information can be found by clicking this link: [Reporting Bridge Damage Memos | Structure Maintenance And Investigations \(ca.gov\)](#)

H.04.01 Post-Earthquake Inspections

There are two district-related response responsibilities following an earthquake: roadway inspections and structure inspections. Each district has their own damage thresholds that depend on the geography, soil type, history of slides, and rural or urban areas. Our California state bridges have had many years of seismic design and retrofit evolution raising the bridge response thresholds and reducing the amount of damage seen prior to 1984. Roadway and slope design basically remain unchanged, but there are regions where slides, failing shoulders, and approach settling are major concerns and need to be addressed.

Each event response is unique and is dependent on the proximity to the earthquake epicenter and measured ground motion.

Post-earthquake inspections of roadways are the responsibility of the district maintenance personnel and other district road crews.

Post-earthquake inspections of bridges will be conducted under the direction of District Maintenance Area Supervisors, ABMEs, and Structure Construction Engineers depending on the level of intensity and extent of damage.

Richter Magnitudes less than 5.5:

Roadway:

Post-earthquake response for magnitudes less than 5.5 will be the decision of the district to send maintenance crews to inspect affected areas. The response should be based on historical roadway damage in previous earthquakes of that district. It is expected that there will be little roadway damage unless it is in combination with heavy rains and other conditions that may cause slides.

If damage is found, such as settled approaches/roadways, missing guardrails, etc., then Maintenance area supervisors should inspect all roadways within the affected area. If significant damage is detected, then the affected radius should be increased to 10 miles.

Bridges:

An earthquake of less than 5.5 magnitude is considered too low to cause any bridge damage. Although unexpected, any earthquake related damage found by district Maintenance personnel must be reported to SM&I.

Richter Magnitudes 5.5 to 6.2:

Roadway:

Post-earthquake roadway response for magnitudes 5.5 to 6.2 will be the responsibility for each district to send maintenance crews to patrol any affected areas in a 5-mile radius of the highest ground motion or epicenter. It is expected that there will be minor damage or settling to approaches and roadways in this range of magnitudes. If any significant roadway earthquake damage is found by district personnel, then the affected radius should be increased to 10 miles.

Bridges:

Only minor bridge damage is expected within the 5.5 to 6.2 magnitude limits. Specific site conditions can make damage more probable.

Maintenance area supervisors should inspect all bridges within a 5-mile radius of the epicenter. If significant damage is detected, then the affected radius should be increased to 10 miles. SM&I must be immediately notified of any earthquake-related damage.

Richter Magnitudes greater than 6.2:

Response for earthquakes with magnitudes greater than 6.2 will combine the roadways and bridge response. Although the roadways likely will sustain damage, it is the structure damage that will be the most immediate concern for the traveling public.

Based on historical California earthquake damage assessments, minor to moderate bridge damage would be expected when the earthquake magnitudes are in the 6.2 to 6.5 range. When the magnitudes are greater than 6.6, then the damage levels begin to compromise the overall integrity of bridges. The Richter magnitude is determined from the logarithm of amplitude of waves recorded from an event. Each 0.2 increase in magnitude corresponds to a doubling of the energy released. When the magnitude goes beyond 6.7, the energy increases dramatically (doubling each 0.2 increase) and greatly increases the amount of damage in a relatively short range at the upper levels.

Roadway:

Post-earthquake response for magnitudes greater than 6.2 will be the responsibility for each district to send maintenance crews to patrol any affected areas in a 10-mile radius of the highest ground motion or epicenter. It is expected that there will be minor to major damage or settling to approaches and roadways in this range of magnitudes. If any significant roadway earthquake damage is found by district personnel, then the affected inspection radius should be increased to 25 miles.

Bridges:

Bridge damage resulting from these magnitudes is probable. Specific site conditions can increase the probability of significant damage. Bridge damage may range from minor to catastrophic depending on structure type and location to the fault.

For earthquakes over 6.2 magnitude, District Maintenance Area Supervisors should inspect all bridges within a 5-mile radius of the epicenter. If significant damage is detected, then the affected radius should be increased to 10 miles. SM&I must be immediately notified of any earthquake-related damage.

For earthquakes of 6.2 to 6.6 magnitude, ABMEs and Structure Construction Engineers will prepare for mobilization based on reported damage. If widespread damage is obvious, ABMEs and local Structure Construction Engineers will immediately conduct independent damage inspections of bridges. SM&I will act as inspection lead and will coordinate systematic bridge damage assessments of the entire affected area.

District Maintenance Area Supervisors and Structures Construction must be notified of these efforts and may act as lead until SM&I is fully mobilized.

For events over 6.7 magnitude, SM&I will analyze the scale of damage expected and then mobilize in teams from Southern and Northern California. District Area Maintenance Supervisors should inspect all bridges within a 10-mile radius of the epicenter. If significant damage is detected, then the affected radius should be increased to 20 miles. SM&I must be immediately notified of any earthquake-related damage so they can focus their response effort.

H.04.02 Post-Fire Inspections

Fire or heat consumes material, weakens supporting members, or causes superficial damage. Extreme heat will melt steel, burn through timber beams, and can change the properties of concrete. Heat-related emergencies happen quickly and can be very hazardous to responders.

In the event of fire, first responders should ensure the safety of the public by performing a rapid safety assessment for fire-weakened or collapsed bridges. SM&I should be contacted immediately with photos of any areas of concern. First responders should collect any information available regarding the temperature and duration of the fire near the structure from the responding fire department.

Refer to the “FIRE DAMAGE ASSESSMENT FOR BRIDGES” section of the First Responder Bridge Assessment Guide (FRBAG) for additional guidance.

H.04.03 Post-Flood Inspections

Bridges with foundations vulnerable to flood damage are classified as scour critical. Scour critical bridges are identified for each District. Each scour critical bridge has a Scour Plan of Action (POA). The POA includes a scour evaluation summary, scour history, countermeasure recommendations, a monitoring plan, a bridge closure plan with criteria for closure, a detour route, and contact information for key personnel.

First responders should be aware of the scour critical bridges within their districts and have copies of the POAs readily available. First responders should review the POAs and understand

the roles and responsibilities in advance of an upcoming rainy season. After inspection of scour critical bridges, first responders should communicate their findings to SM&I Hydraulics Branch via the web form link provided on the POA and SM&I intranet site.

Refer to the “FLOOD DAMAGE ASSESSMENT FOR BRIDGES” section of the FRBAG for additional guidance.

H.04.04 Post-Overheight Impact Inspections

Overheight vehicle impacts of bridges (also known as “high load hits”) can result in damage that ranges from minor to major, possibly requiring bridge closure. The Bridge Crew is the first responder in such events and should immediately take necessary actions to ensure the safety of the traveling public. For all such events, the ABME and Area Bridge Senior should be notified including the bridge number, photos, and details of the impacted area.

If it is determined that an inspection by SM&I is required due to concerns about the load carrying capacity of the bridge, the Bridge Crew will need to provide the necessary equipment (i.e., lift truck, bucket truck, etc.) for the inspector to perform a complete assessment of the damage.

Refer to the “OVERHEIGHT IMPACT DAMAGE ASSESSMENT FOR BRIDGES” section of the FRBAG for additional guidance.

H.05 Movable Span Bridges - Inspection and Testing

The mechanical and electrical equipment of movable span bridges will be inspected once a year by qualified mechanical and electrical engineers from the Division of Engineering Services, Office of Electrical, Mechanical, Water and Wastewater Engineering (EMWW). Refer to Volume 1, Chapter J2, of the Maintenance Manual for additional information.

H.06 Structure Type Nomenclature

SM&I assigns an official bridge number and name to all "Bridges" meeting the following criteria:

- (A) All structures or groups of closely spaced (less than half pipe diameter) pipes which, measured parallel to the roadway centerline, have a length of more than 20-feet between the inside faces of the end abutments should be carried as bridges regardless of the length of the spans making up this total.
- (B) In addition, bridge numbers or other asset numbers may be assigned to other structures where periodic inspections with written reports are desired. This includes such structures as seal slabs, specially designated culverts, short bridges, and other unique structures.
- (C) The name assigned to each structure given a bridge number has an association with its function as a highway facility. Name types are defined below, and illustrations can be seen in Appendix H-1.

(1) Bridge

This term is used in a name when the function of the structure is to carry traffic over a watercourse such as a bay, canyon, river, creek, wash, or slough.

(2) Overhead

This term is used in a name when the function of the structure is to carry a state highway over a railroad.

(3) Underpass

This term is used in a name when the function of the structure is to carry a railroad and provides for passage of a state highway under the railroad.

(4) Overcrossing

This term is used in the name of a structure when a county road, city street, or any facility (pipelines, tramways, pedestrian crossings, cattle-passes, equestrian crossings, etc.), other than railroads, is carried on the bridge structure and State highway traffic flows under the structure.

(5) Undercrossing

This term is used in the name of a structure that carries State highway traffic and provides for passage of a city street, county road, or other facility other than a railroad or another State highway, under the State highway.

(6) Separation

This term is used in the name of a structure that carries traffic of one State highway over another State highway.

(7) Viaduct

This term is used in the name of a structure of any length that carries State highway traffic along a steep side hill. It also is used as a compromise name for a long structure crossing over several facilities of approximately the same importance, any one of which alone would require a name category of Bridge, Overhead, Undercrossing, or Separation.

(8) Tunnel

This term refers to a roadway section through a mass of earth. Some undercrossings and separations are also tunnels.

(9) Tube

This term describes an underwater roadway facility constructed by lowering a

prefabricated section in an excavated trench.

(10) Pumping Plant

This term is used in the name of a facility that is assigned an asset number because it is an intricate facility of structural, mechanical, and electrical combination for the purpose of preventing water inundation of the highway.

H.07 Minor Defects

Minor defects are those that can be corrected with little or no risk of structure collapse or rendering of damage to adjacent or related members while making repairs or replacements.

Listed here are some examples of this class of defect:

- (A) Damaged or misplaced clearance markers.
- (B) Damaged or missing advisory and warning signs (Narrow Bridge, One Lane Bridge, One Lane Bridge for Trucks and Buses, etc.).
- (C) Scaled or deteriorated paint on timber railings and curbs.
- (D) Damaged or deteriorated railings and curbs.
- (E) Uneven or cracked approach and deck surfacing.
- (F) Broken or loose timber decking.
- (G) Damaged or ineffective joint seals.
- (H) Accumulated drift adjacent to bents and piers.
- (I) Minor erosion.
- (J) Accumulated dirt or debris on decks, near stringer ends at supports, adjacent to bearings, and on chords of trusses.
- (K) Plugged drains.
- (L) Settlement or roughness of approach.
- (M) Fire hazards.
- (N) Faulty electrical contacts.

H.08 Major Defects

Some defects are considered major because they involve individual members that affect the structural stability of an entire span, thus requiring underpinning of the span or supplementing of

the member before removal. Others are included in this group because the cause of the defect, and thus the measures needed to correct the defect, are numerous and varied requiring structural or other technical advice, or the defect may cause equipment failure. Examples of this type of defect follow:

- (A) Bent or damaged steel beams, girders, or truss members.
- (B) Cracked or spalled concrete members, other than curb or railing.
- (C) Crushed or decayed timber stringers, caps, posts, or piles.
- (D) Broken or weakened chord members of failed truss joints.
- (E) Unusual looseness or vibration of truss members.
- (F) Loosened or decayed timber deck over an extended area.
- (G) Defective bearings.
- (H) Broken or damaged Joint Seal Assemblies.
- (I) Settled bents or piers.
- (J) Major erosion or scour.
- (K) Lack of paint on steel members, other than curb and railing.
- (L) Extensive fire damage.
- (M) Poor alignment or balance of movable bridge spans.
- (N) Excessive noise or vibration from operating machinery.
- (O) Lack of lubricant in machinery bearings.
- (P) Loose bolts.
- (Q) Broken timber stringers.
- (R) Ineffective supplemental bents.
- (S) Sparking or burning of electrical equipment.
- (T) Electrical motors drawing high amperage or failure to operate as designed.
- (U) Other major defects as described in the AASHTO Manual for Bridge Evaluation.

H.09 Priority Work Recommendations

Priority work recommendations typically consist of maintenance actions to mitigate conditions that impact the strength or serviceability of a structure element, where those conditions do not pose a safety risk to the traveling public or affect the stability of the structure. Priority work recommendations should be programmed for completion at the first practical opportunity.

Priority work recommendations may include, but are not limited to maintenance actions to mitigate significant or unstable deck spalling, scour conditions that may rapidly progress in subsequent flow events, joint seal assemblies that are in a state of incipient failure, significant approach deterioration, damaged but intact bridge rail, drainage/ponding issues, mechanical/electrical conditions that impact operational reliability and placement of vertical clearance signs where measured clearances are less than previously recorded clearances and/or existing signs by three or more inches.

For additional information regarding priority work recommendations, refer to Section 8.7 of the SM&I Procedures Manual, referenced in Section [H.01.01](#) of this chapter.

H.10 Repair Materials and Procedures

When making repairs of defects, whether minor or major, all work should conform as closely as practicable to requirements of the current Standard Specifications. Emergency and temporary work should be planned to best meet the situation and protect traffic. Wherever applicable in all work, materials and procedures listed in this section should be used, unless variations from these are stated in the work recommendation listed in the reports submitted by SM&I, or upon approval of the variation by the ABME.

H.10.01 Epoxy for Bonding Concrete

Epoxy is a two-component mixture that will adhere to most clean hard substances such as steel and concrete. When cured, it forms a strong material that can be used in certain structural repairs.

Epoxy can be pumped into cracks in concrete to re-bond the separated pieces or spaces between steel expansion dams and concrete deck.

Two-component epoxy should be carefully proportioned in accordance with directions supplied by the manufacturer. The two components must be mixed thoroughly before using and placed immediately after mixing.

Pot life of the mixed epoxy varies with the temperature of the material. When confined, the heat produced by the chemical reaction is not dissipated from the mix, so the epoxy becomes progressively warmer, and the chemical reaction becomes progressively accelerated. In confined lots, the pot life may be only a few minutes. The time required to harden is increased many folds by spreading out the material so its heat from chemical reaction is conducted away. If the epoxy is frozen immediately after mixing, the chemical process can be virtually stopped. So, by artificial heating or cooling, the time of set can be sped up or slowed down as is desired.

For proper final cure, the temperature of the epoxy should be a minimum of 65 degrees Fahrenheit for several hours. When heating to accelerate the curing, a direct flame should not be

applied to the epoxy surface. A 1-inch cover of sand, or a steel plate supported to clear the epoxy surface by 1-inch or more, makes an effective protector from the flame. Either conducts the heat effectively to the epoxy. Never heat the epoxy to the boiling point or flame point.

To pump epoxy into cracks, use an epoxy injection pump. Cracks in concrete can be filled by inserting ½-inch pipes held in with epoxy or Portland cement grout. Open cracks to be pumped must be sealed along edges in advance of pumping with an epoxy containing a thixotropic agent to prevent flowing away before setting. Other surface mounted fittings specifically designed for epoxy injection may also be used.

Any tools or equipment used with epoxies must be cleaned before the epoxy has set (the sooner the easier), or it will be impossible to wash the epoxy off. Toluene, methylethylketone, or lacquer thinner, may be used to clean tools. Use caution with these materials, as they are flammable and can be hazardous to health. Be sure to follow all label instructions.

Epoxies suitable for the above uses can be obtained from the Transportation Laboratory (Trans Lab).

H.10.02 Portland Cement Concrete and Steel Reinforcement

During concrete placement, mechanical vibrators must be used to consolidate the concrete mix. Aggregates should be clean and well graded. Use as little water as possible to provide a workable mix. Reinforcing steel must be placed as shown on plans and securely held in position when placing concrete. Forms should be constructed adequately to prevent leaks and to hold in proper line and grade while placing and curing the concrete.

There are essentially two categories of concrete repair materials. One category applies to vertical and overhead applications. Vertical and overhead patch materials are formulated to provide good bond strength, be compatible with the existing concrete, and can be placed without forms. Vertical and overhead patch material may not necessarily be rapid setting or have high early strength. The second category applies to traffic bearing horizontal applications. Horizontal patch material is formulated to be rapid setting, gain high early strength, and have good abrasion resistance. It is important to indicate what type of application is being performed when requesting a repair material recommendation from the Translab.

There are many rapid setting high-strength concrete materials available for structural repairs and patches. These materials consist of either magnesium phosphate concrete, modified high alumina-based concrete, or Portland Cement based concrete. The number of products available for patching purposes is too voluminous to mention in this chapter. Additional information not covered in this chapter, can be located in the document entitled “Rapid Set Materials for Repairs to Portland Cement Concrete Pavement and Structures” produced by the Office of Central Laboratories-Concrete Materials Testing.

This document discusses characteristics and the dos and don'ts. It is important to note that the materials in this publication are not pre-approved. Lots are acceptance tested.

Contact the Office of Central Laboratories-Concrete Materials Testing to verify that a particular lot of material has been approved for use.

There is a co-polymer called High Molecular Weight Methacrylate (HMWM). This product is especially good for filling cracks in concrete and knitting the concrete together. Special precautions are required when using it. Refer to "Code of Safe Operating Practice - Bridge and Highway Concrete Repairs Using HMWM Resins."

The following table gives approximate quantities of materials needed to produce one (1) cubic yard of each of several classes of Portland Cement concrete. These mixes produce a mix with about a 4-inch slump if the aggregates are well graded. Adjustments must be made to produce a workable mix with proper yield.

| Class | Cement Sacks = Pounds | Combined Aggregates Pounds = Cubic Yards (loose measure) | Water Pounds = Gallons |
|-------|--------------------------|--|---------------------------|
| "A" | 6 = 564 | 3200 = 0.99 | 290 = 35 |
| "B" | 5 = 470 | 3320 = 1.03 | 290 = 35 |
| "C" | 4 = 376 | 3440 = 1.06 | 267 = 32 |
| "D" | 7 = 658 | 3150 = 0.97 | 290 = 35 |

Mortar for patching, etc., can be composed of well-graded sand and cement in the following approximate proportions measured by volume:

| | |
|---------|--------------------------------|
| Cement. | 1 Part |
| Sand | 3 Parts |
| Water | Sufficient to make a stiff mix |

Steel reinforcing bars (See Appendix H-2) must comply with ASTM Designation A706/A706M. The English bar numbers are based on the nearest number of 1/8-inch included in the nominal diameter of the bar.

| | | | | | | | | | | | |
|---------|----|----|----|----|----|----|----|----|----|----|----|
| English | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 14 | 18 |
| Metric | 10 | 13 | 16 | 19 | 22 | 25 | 29 | 32 | 36 | 43 | 57 |

The weights have been adopted as standards. Bar number 2 is produced in plain rounds only. Existing bars must be replaced with bars of equivalent cross-sectional area. When replacing square bars with round, use the next larger round bar size (i.e., replace a 5/8" square bar with a #6 round bar).

Splicing of reinforcing bars must comply with Section 52-6 of the Standard Specifications. This section covers welded, mechanical, and lap splices. In general, lap splices may be as follows: Number 8 and smaller bars must be lapped at least 45 bar diameters of the smaller bar joined, Number 9, 10 and 11 bars must be lapped at least 60 bar diameters of the smaller bar joined. Number 14 and 18 bars may not be lap spliced.

When joining new concrete to old, chip or saw 1/2-inch or deeper along edges of concrete to be

repaired to eliminate feather edges and produce neat, straight-line joints. Chip away all unsound and loose fragments of concrete within the repair area. Remove all foreign material and rust from concrete and steel by sandblasting or wire brushing. When patching spalls, chip about 1-inch under the reinforcing steel in several locations to help anchor the patch or apply two-component epoxy to bond the entire surface to be repaired (see Section H.09.1). Then place mortar or Portland Cement Concrete to replace all missing concrete. However, it should be noted that Rapid Set materials do not require the use of an epoxy bond coat.

The color of new mortar or concrete should be made to match original concrete when it is cured. This usually can be accomplished by preparing a combination of 1/3 white cement and 2/3 normal cement for use in making the concrete or mortar. The proportion of white cement should be varied as required.

Strike off and finish of patches should be done with wood or stone floats only. Steel floats impart a dark color to the surface.

Rapid setting concrete or mortar should be cured as recommended in "Rapid Set Materials for repair to Portland Cement Concrete Pavement and Structures." All other concrete or mortar should be cured by keeping damp with water for 7 days, or by coating with an approved colorless curing compound.

Patching spalls in a concrete deck with asphalt concrete (AC) should be avoided.

H.10.03 Steel

Steel members in structures are repaired by replacing all or part of the member, straightening, welding tears, and welding or bolting scabs over defects. Any repairs require pre-approval by the ABME.

Heat can be of great assistance in straightening members if strategically applied but must not be used without the approval of the ABME. When such approval is given, the member must be relieved of all dead and live load before heating.

Only common mild "carbon" steel members should be heated. The maximum temperature should not exceed 1300 degrees Fahrenheit. At that temperature, common mild carbon steels are reduced in yield point and ultimate strengths to about 10 percent of their values at 100 degrees Fahrenheit.

When cooled off they return to approximately original strength and characteristics. Some of the high strength steels are decidedly changed by such heat cycles.

High strength bolts of the same diameter as the rivets removed must be used to replace rivets in re-assembly. These bolts may be satisfactorily tightened by properly using pre-painted load indicating washers.

All welding is done by a Structural Steel Welder. The type and location of welds can dramatically reduce the fatigue life of a member. Welding on any bridge structural component must not be performed without the approval of the ABME.

H.10.03.01 Overcoating of Painted Steel Surfaces

Painting of structure steel members requires proper PPE, containment, surface preparations, existing condition assessment, as well as proper application and environmental conditions to ensure quality workmanship and the longevity of the coating system. The following guidelines are referenced from Section 59 Structural Steel Coatings of the Standard Plans and Standard Specifications, provided in Section H.01.01 of this chapter.

Containment and lighting must be provided for the cleaning and painting of structural steel.

- Containment systems must contain all water, resulting debris, and visible dust produced when the existing paint system is disturbed. The containment system must be one of the following:
 - Ventilated containment system.
 - Vacuum-shrouded surface preparation equipment with drapes and ground covers.
 - Equivalent containment system if authorize.
- Lighting systems should be designed and installed following the Society for Protective Coatings (SSPC) Guide 12, during preparation, cleaning, painting, and inspection.

WORK AREA ILLUMINATION REQUIREMENTS IN LUX (FC)

| | MINIMUM | RECOMMENDED |
|---|----------------------------|-------------|
| Project staging areas (large objects, trip/fall hazards, operating or moving support equipment are present) | 54 (5) ^(A) | 108 (10) |
| General work area ^(A) | 108 (10) | 215 (20) |
| Task-specific (surface preparation and coating application) ^(B) | 215 (20) ^(B) | 538 (50) |
| Task-specific (inspection) | 538 (50) ^{(A)(C)} | 2153 (200) |

^(A) The level of illumination throughout a work area, measured at various locations on the horizontal work-plane, at least 1.8 m (6 ft) from the nearest light sources. (See Section 6.1). An illumination level of 215 lux (20 fc) is recommended for corridors, scaffolds, and other walking surfaces.

^(B) The level of illumination for performing specific visual tasks (i.e., surface preparation, coating application,) measured at the work surface in conjunction with the intended light source (see Section 6.1).

^(C) If permitted by project requirements, 323 lux (30 fc) of ambient light supplemented by portable or hand-held lighting may be used to achieve the recommended minimum of 538 lux (50 fc) at each point of inspection.

Washing of painted surfaces must be done be when cleaning and painting of structural steel.

- Pressure wash with a rotary tip to remove loosely adhered coatings and contaminants from surfaces. Use a pressure wash system with a nozzle pressure from 2,500 psi to 5,000 psi.
- Steam clean to remove dirt, grease, loose chalky paint, and other foreign material from surfaces. Use a biodegradable detergent during steam cleaning. After steam cleaning, pressure rinse cleaned surfaces with water.

After washing, the painted surface must be tested for soluble salts and be free from gloss, grease (water bead tests), moisture, dust, and deleterious material that would prevent bonding of succeeding coats. Measure levels of soluble salts on surfaces using a retrieval method such as Bresle Patch and Quantab Chloride indicator strip specified in SSPC-Guide 15. The levels of soluble salts must not exceed 10 µg/sq cm.

Surface preparation

- Power tool cleaning is appropriate when surface preparation by blasting cleaning is not

possible due to limited access, spot areas cleaning, irregular shapes, and geometry of the surfaces. Power tool cleaning must not be used in harsh, coastal environment. Power tools only remove loose rust and cannot remove sufficient soluble salt level less than 10 $\mu\text{g}/\text{cm}^2$. Any paint system applied without sufficient removal of soluble salt will show deterioration within three years and will require extensive maintenance in less than five to eight years.

- Blast cleaning must be used in harsh, coastal environment. The level of soluble salt must be tested on blasted steel before applying the undercoat. The levels of soluble salts must not exceed 10 $\mu\text{g}/\text{sq cm}$.

Paint condition assessment

When the total film builds exceed 30 mils on an existing painted member, a full removal must be considered.

- Overcoating thick paint will eventually cause adhesive and cohesive failure of the underlying coatings, as well as stressing the underlying orange or red base primers.

Rusted painted steel members must be blasted to bare metal before overcoating.

- If rust is widespread, freckling throughout the members exceeding 30% of the total painted areas, 100% full blast of all members must be performed.
- If rust is isolated and sparse on members, only spot blast is required. Limits of spot blast areas should be neatly squared to contain all concentrated rust.
- A primer coat must be applied to blasted bare steel on the same day of blasting or earliest possible to prevent flash rust.

Bubbled, curled, cracked, or lifted finish coats must be removed down to sound paint or metal.

- Consider full removal if the defect areas exceed 30% of the total painted areas.
- Spot remove defective coats to tightly adhered paint by power tools or whip blast.
- Remove gloss from existing paint by lightly roughen areas of gloss using 100-200-grit sandpaper.
- Feathered all coats to tightly adhered paint before overcoating.

Fire damaged paint must be fully blasted and removed where coatings have failed.

- All soot must be cleaned from the span from support to support to determine the extent of paint damages.
- Undamaged paint must be free of soot, grease, and contaminants before overcoating.
- Overcoat the entire span from support to support where the fire had started.

Paint Application (State specified PWB paint system)

Use of paint gun extensions and aerosol cans are prohibited. Apply paint to dry clean surfaces in a neat manner by brush, spray, or roller in any combination.

Apply four coats paint system when the surface prep is to bare metal.

- Two coats of primers with the dry film thickness 2-3 mils per coat; two coats of finish coats with the dry film thickness 1.5-3 mils per coat. Total thickness, all coats should be 7-12 mils.

Apply three coats paint system when the surface prep is to tightly adhere paint.

- The first coat is the primer with the dry film thickness 2-3 mils; the two subsequent coats are finish coats with the dry film thickness 1.5-3 mils per coat. Total thickness, all coats should be 5-9 mils.

Apply a stripe coat on all edges, corners, seams, crevices, interior angles, junctions of joining members, weld lines, and similar surface irregularities.

All coatings must be applied within specified limits for temperature and relative humidity as define in Section 59-1.03B, Weather Conditions, of the Standard Specifications.

Limits for weather conditions

- Air: 51-100 °F
 - Surface: 51-100 °F
 - Relative Humidity: < 75%
 - Dew point: Surface temp °F \geq 5 °F Dew point
- Applying or curing PWB 145/146 primer coats out of weather limits can result in surfactant leaching onto the surface due to dew point and condensation on the primer. Surfactant appears as milky spots must be pressure washed until there is no soapy/foamy appearance on the surface. If the surfactant is not removed from the primer, the surfactant will continue to absorb moisture from the environment, and eventually creating blisters in the finish coats.
 - PB-201 red phenolic primer is intended for brush, dabber, or mitt application to areas with limited access like crevices with pack rust, bearings, and recesses which have marginally cleaned steel surfaces. It is not intended for use on galvanized, thermal spray, or any retrofitted steel like bolts, or plates coated with zinc rich primers. Doing so will result in saponification of the primer causing blisters, and loss of intercoat adhesion to the finish coats within 1 to 2 years.

When using other approved or authorized coating, see the manufacture's product data sheet for the coating.

Each paint application should be thoroughly cured before the next application. Paint application cured out of permissible weather conditions can result in surfactant, blistering, performance issues, and shorten the life expectancy. Correct skips, holidays, thin areas, or other deficiencies before the next application. Painted surfaces being covered must be free from moisture, dust, grease, and deleterious material that would prevent bonding of succeeding coats.

The Paint Inspector may require you to remove and reapply paint to areas with runs, sags, thin and excessively thick areas in the paint film, skips, holidays, or areas of non-uniform appearance. Remove paint or paint stains on surfaces not designated to be painted.

H.10.03.02 Graffiti Abatement of Painted Steel Surfaces

Pressure wash with rotary tip to remove graffiti, loose paint, and contaminants. Use a pressure wash system with a nozzle pressure from 2,500 psi to 5,000 psi. Follow appropriate BMP for

water containment.

If pressure wash is not feasible, remove loosely adhering coatings with wire brush or scrapers.

Use only State specified PWB paint system to match and paint existing. Use of any other types of paint will eventually crack, fail, and peel.

- Contact the nearest Paint Supervisors from one of Districts 4, 7, 10, 11 to obtain PWB paint and matching colors.
- Contact SM&I Bridge Paint Program Advisor to provide more information per bridge location or incident.

Apply PWB paint with brush and roll, and neatly square the graffiti abatement overcoating.

H.10.03.03 Graffiti Abatement of Concrete Surfaces

Pressure wash with rotary tip to remove graffiti. Use a pressure wash system with a nozzle pressure from 2,500 psi to 5,000 psi. Follow appropriate BMP for water containment.

If pressure wash is not feasible, overcoat with matching grey concrete paint.

H.10.04 Timber

Timber members in structures are repaired by replacing or supplementing. See Section H10 for additional information.

H.10.05 Deck Surfacing

Because it adds additional load on a bridge, deck surfacing is not be placed without prior written approval from SM&I.

Surfacing for concrete bridge decks should be polyester concrete or an approved High Friction Surface Treatment (HFST), unless otherwise specified by SM&I. Multi-layer polymer concrete overlays are only used to increase skid resistance. The surfacing should be placed by conventional methods and adjusted to produce a smooth riding surface.

The use of Asphalt Concrete (AC) as surfacing for concrete decks should be avoided. AC surfacing obscures developing deck problems such as cracking and delamination and can accelerate existing problems such as Alkali-Silica Reactivity (ASR or “reactive aggregate”) and constrains preventive maintenance and rehabilitation methods without removal of the surfacing. In limited site-specific locations, AC surfacing may be considered for use. The use of all AC surfacing for concrete bridge decks requires prior written approval from SM&I.

For timber or thin steel plate decks, AC surfacing may be required to increase skid resistance. In these applications, the asphalt binder, aggregate gradation, and proportioning must be adjusted to produce a mix which will adhere well, be relatively impervious, have above average flexibility and provide a skid resistant surface. Usually, these qualities can be achieved with an open graded mix placed over a heavy asphalt seal application on the deck. Climatic, environmental, and

traffic usage should be considered in asphalt selection and mix proportioning. The surfacing should be placed by conventional methods and adjusted to produce a smooth riding surface.

When surfacing highway approaches to a bridge with AC, taper the new surfacing down to a smooth junction with the deck grade at the paving notches. The approaches should be ground down about 1-inch near the paving notch so that the new surfacing maintains about a 1-inch minimum thickness at the transition to prevent raveling.

H.11 Repair and Reconstruction

H.11.01 Timber Girders in Reconstruction

Salvaged girders, if in good condition and of the proper size, may be reused. Tops of girders must be lined up to a true plane and placed with the same edge up as when formerly used.

Girders should be cut to a length not exceeding the distance center to center of caps or floor beams by more than one foot. The length must be sufficient to provide at least 6-inches of bearing at each end. When using new girders, it is necessary to inspect for knots, and to place girders so that the greatest volume of knots is in the upper third.

If knots are in the middle third, they must be placed with the greatest volume above the centerline.

H.11.02 Timber Girders in Existing Bridge as Supplement or Replacement

A stringer to be placed in an existing span should be of the same depth and of equal width as other girders in the panel when the replacement stringer is of the same kind of material as the existing stringer. When Douglas Fir (DF) girders are used to replace or supplement Redwood (RW) girders, the DF stringer should have the same depth, but may have two-thirds of the width of the RW stringer. In case of an emergency, the best available sizes may be temporarily used.

It is acceptable to keep bridging in place, and to set additional pieces as necessary. See Appendix H-2 for cuts required and method to use when installing a supplemental stringer or replacing an existing one.

Use of an adze to fit girders to deck sag is prohibited. The end wedges must be set to bring the stringer to same degree of tightness against deck at the center of span as adjacent girders. As the new stringer acquires sag and fits into place, wedges should be tightened. Wedges should always be secured in place with double-headed nails.

The portion of each upper edge of each stringer that extends beyond the center of the bent should be tapered down so it does not contact the bottom of deck. This is to prevent the deck from being pushed up over supports when the stringer is deflected under live loads.

If shims or wedges are necessary under girders, they should be substantial and of either DF or RW and should be tacked with double headed nails when set. Shingles are acceptable for the purpose.

H.11.03 Supplemental Bent

When an emergency occurs requiring immediate installation of a supplemental bent, approval by SM&I must be obtained in all cases. Details of a supplemental timber bent can be seen in Appendix H-2.

In constructing and maintaining a supplemental bent, shims may be used as required so that all girders bear on the cap. Shims placed under posts must be the full width of the post plus 1-inch. A series of thin shims should never be stacked. A block or plate plus two shims or just two wedges should be used. Shims or wedges must be nailed with double-headed nails.

When a bridge supplemental bent washes out or is compromised, it must be replaced immediately. If replacement is not possible, the ABME must be notified immediately, as the bridge may need to be posted for restricted load, or closed, until strengthened.

H.11.04 Bridge Rail

Damaged or deteriorated concrete railing usually will require recasting of the affected areas with new concrete. Minor spalls in the concrete surface can be patched with portland cement mortar. Concrete cracks may be injected with epoxy.

Steel railing frequently is so extensively damaged that replacement of panels is more economical than straightening or replacing miscellaneous pieces. When a panel of prefabricated railing is to be replaced, it is expedient to purchase it from the original fabricator because they are the only one who has the shop drawing available and therefore is in position to make a quick delivery.

When it is necessary to replace or repair a substantial amount of damaged or deteriorated concrete or metal railing, SM&I must be notified and will furnish approved details.

Timber rail and wheel guards have many variations and designs. When small portions are damaged, it should be replaced in kind. If all, or practically all, of any timber rail and wheel guard must be replaced, the entire rail and wheel guard should be replaced as necessary to convert it all to the standard shown in Appendix H-2, or all should be replaced with a metal beam rail subject to approval by SM&I.

H.11.05 Temporary Bridge

In the event an existing bridge washes out or is destroyed by some other means, SM&I must be notified immediately. SM&I will advise on an immediate plan of action and will furnish plans for both temporary and permanent repairs. When such a structure is necessary, SM&I will decide the appropriate type to be built based on materials available, obstacle to be crossed, conditions at the site, and other related factors.

H.12 Miscellaneous

H.12.01 Mark High Water

A record of the highest high-water mark for major streams should be indicated by painting a white line 1-inch wide and 18-inches long, together with the date on any convenient abutment, pier, or column.

Records should also be made of abnormally high water, unusual flow conditions, and any other peculiar conditions during high water periods. These conditions tend to cause scour of the streambed or bank and can alter the channel flow.

H.12.02 Approach Surfacing

When resurfacing the highway, the new surfacing should be tapered down to a smooth junction with the existing deck grade at the paving notches or the approach slabs.

H.12.03 Bridge Numbers, Names, and Date Built

The bridge number, name assigned to each bridge by SM&I, and the year it was built should be plainly stenciled on each structure in a position visible to traffic. If a stencil must contain a postmile indicator, it must be accurate within the route. Example: two stencils placed at each abutment of a bridge cannot have the same postmile reading. Post Miles markers should be used when possible.

Bridge identification information should be in a place visible to traffic from the roadway at both the upper and lower levels of traffic. At the upper level, it should be painted on the bridge barrier near the paving notch to the right of approaching traffic on both ends of the structure. At the lower level, if required, it should be painted on a column or wingwall to the right of approaching traffic. Bridge supports should be numbered to follow the direction of increasing stations along a route; stationing direction and other information is typically provided by the district.

Exceptions:

- For structures with no columns adjacent to the roadway, the bridge name, number, and year constructed should be painted on the abutment wingwall or on a column in the center of the roadway to the left of traffic.
- On “long” structures over 300 feet long or consisting of five or more spans, each bent, or pier, should be identified for maintenance personnel, both underneath and on the barrier along the bridge at each support. The support identification numbers should be the same as those used in the contract plans. Examples: BENT 2R, PIER 15L, etc.
- For structures with long adjacent retaining walls or approaches where metal beam bridge railings extend well beyond the structure, the structure identification should be painted on the barrier's concrete end block.
- When graffiti or other vandalism is an issue at isolated locations you may move the bridge identification on the superstructure. It should be at least 9 feet high. You may also contact the ABME to discuss other options when responding to repeated vandalism.
- G-11 or equivalent name signs may be installed at the district’s discretion, G-11 name signs are used where the structure or stream is of sufficient size or importance to justify publicizing its name. If the G-11 sign contains a postmile indicator, it must be accurate within the route. Example: two signs placed at each

abutment of a bridge, cannot have the same postmile reading. Installation of this sign should conform to requirements of the Traffic Manual, and approval of the Traffic Operations Program. Typical name types are shown in Section H.06 of this chapter.

Locations at which names, numbers, and dates should be painted are depicted in the sketches in Appendix H-2. The lettering size should be 2.5 inches high and in black or white to contrast with the background provided by the structure. Backgrounds may be painted for purposes of enhancing the lettering.

For large structures, the support numbers should be painted on the columns and corresponding rail locations for reference during inspections. The ABME can be contacted to obtain the proper numbering convention, if needed.

H.12.04 Vertical Clearance

Every structure over a State highway having a vertical clearance of 15 feet 6 inches or less, exclusive of shoulders, must have the clearance indicated by a sign in adherence to the California Manual on Uniform Traffic Control Devices found at the following link:

<https://dot.ca.gov/programs/safety-programs/camutcd>. This applies to all underpasses, overheads, viaducts, overcrossings, undercrossings, and grade separations., and pedestrian overcrossings.

Per the adoption of the 2003 MUTCD as of May 20, 2004, the following sign codes are now the current codes for vertical clearance signing in California:

- W34 (CA) was replaced with the Federal W-12-2 “Low Clearance” sign for use in California.
- W34A (CA) “Distance Ahead” Plaque has been retained for use in California.
- W34B (CA) was replaced with the Federal W12-2a “___FT___IN” plaque for use in California.
- W34C (CA) “CAUTION VERTICAL CLEARANCE___’___” Arrow has been retained for use in California.

The California sign specifications, W34A and W34C, can be found at the Traffic Operations Program webpage, provided in Section H.01.01 of this chapter. The Federal sign specifications, W12-2 and W12-2a, can be found in FHWA’s Standard Highway Sign book or in the MUTCD, reference provided in Section [H.01.01](#) of this chapter.

Policies for all four (4) signs are contained in the California MUTCD, reference provided in Section [H.01.01](#) of this chapter.

Any time there is a planned reduction in vertical clearance of a structure, Maintenance Area Superintendents and Maintenance Supervisors must notify the Caltrans Construction/Maintenance Liaison not less than 15 days prior to the change. Notification must be in writing and a clearance diagram must be attached. Clearance Diagram Form Std TR-0019, TR-0020, and TR-0029 can be obtained from the Caltrans Electronic Forms System, reference provided in Section [H.01.01](#) of this chapter.

Samples of these forms are shown in Appendix H-3 and Appendix H-4. If there is a reduction in

vertical clearance due to unplanned events, the Caltrans Construction/Maintenance Liaison must be notified immediately, and a revised clearance diagram must be sent to the Traffic Operations Transportation Permits Office.

If a new roadway surface is being placed on a section of roadway that travels under a structure, the new roadway surfacing can be feathered out to meet the existing surface grade under the structure a short distance in advance, with no reduction in vertical clearance under the structure.

When a bridge under 15 feet 6 inches is missing a vertical clearance sign or if the posted sign is advertising 3 inches or more incorrect due to roadway overlay/grinding, it is considered a high priority item. When ABMEs encounter this situation, an immediate response may be justified.

H.12.05 Weight and Speed Restrictions

Caltrans has authority, under Section 124 of the California Streets and Highways Code, to restrict the use of or close a bridge considered in imminent danger of failure under legal weight loads. In such cases, weight limit signs of cloth must be posted immediately, showing the safe weight limit for the structure. These temporary signs are available from Material Operations. Each district must have a small supply on hand for immediate use.

Permanent weight limit restrictions are established by the appropriate authority (Caltrans or local agency) issuing an order following an engineering investigation and public hearing, as prescribed in sections 35750, 35751, and 35752 of the California Vehicle Code.

The investigation on behalf of Caltrans is conducted by SM&I. The hearing on behalf of Caltrans is held by an appointee of the Director, usually an employee of SM&I.

These laws require a notice of the hearing be posted upon the bridge or other structure at least five (5) days before the date of hearing. This is done by placing copies of the formal "Notice of Hearing" attached to plywood boards at both ends of the structure in locations visible to traffic. One copy of the notice, showing the time and date of posting and signed by the person erecting the notice, must be returned to the SM&I Headquarters Office.

After the Director, or the Director's appointee, issues an order regarding the bridge/structure weight limits, signs stating the maximum weight limitations must be erected and maintained "at a distance of not more than 500 feet from each end of the bridge or other structure or any approach thereto." (Streets and Highways Code, section 35752.)

When the weight and/or speed restriction signs relating to a bridge are missing or contain incorrect weight and/or speed information, it is considered a high priority item and requires immediate corrective action. When ABMEs encounter this situation, a Record of Critical Finding will be issued, and immediate action is required.

H.12.06 Safety Measures

For detail as to guardrails, clearance markers, and warning and regulatory signs applicable to bridges, see Volume 1, Chapters M1, M2, and M3, of the Maintenance Manual.

H.12.07 Fire Protection

Suitable fire extinguishers should be installed in each control room and machinery room of each drawbridge. In drawbridges where electricity is the prime source of power, only Dry Chemical or Carbon Dioxide extinguishers should be installed. Fire extinguishers must be inspected monthly as provided in the California Code of Regulations, Title 19, Division 1, Chapter 3, referenced in Section [H.01.01](#) of this chapter.

H.12.08 Electrical Equipment

Repair or adjustment of electrical equipment should be done by qualified personnel only.

Permanent changes in the circuitry of drawbridges should not be done without consulting SM&I. This is not intended to prevent electricians from making necessary emergency connections.

H.12.09 Lubrication

Standard items of manufacture, such as electric motors, engines, compressors, gear reducers and pillow blocks incorporating sealed ball or roller bearings, are usually furnished with maintenance manuals which include recommended lubrication practices. These manuals should be made a part of the Maintenance Manual in the control room and the recommended lubrication practices should be followed exactly, unless overruled by “Specific Lubrication Instructions.”

Lubrication of open gears, wire ropes, and sleeve bearings must be varied to meet the conditions under which they operate. Open gears seldom used and subject to accumulation of sand or dirt will be better protected and get less wear by painting with State Specification 8010-61J-45 paint and leaving all oil or grease off the teeth. Due to the great variation in proper lubrication requirements of somewhat similar facilities, the proper practice for each drawbridge will be covered in “Specific Lubrication Instructions.”

The manufacturer’s manual and the “Specific Lubrication Instructions” for each bridge should be made a part of the Special or Supplemental Orders included in data posted in each control room. Refer to the AASHTO Movable Bridge Maintenance, Evaluation, and Inspection Manual for examples of machinery lubrication.

H.12.10 Overhead and Changeable Message Signs

Inspection and maintenance of these signs is covered in Volume 1, Chapter M2, of the Maintenance Manual. SM&I provides inspections and reports, as requested by the district.

H.12.11 Horizontal Restrictions

Maintenance Area Superintendents and supervisors are responsible to notify the Regional Transportation Permit Liaison Engineer of any permanent or semi-permanent horizontal restriction that will reduce usable highway width. Notification must take place at least 15 days prior to placing any device that would reduce horizontal clearance. Such restrictions may include, but are not limited to, the placement of temporary K-rail or any channelizing device that cannot be immediately removed by Maintenance forces. The notification should be in writing, either by memorandum or departmental e-mail. For update contact information for the current Permit Liaison Engineer please contact askbam@dot.ca.gov.

APPENDIX H-1

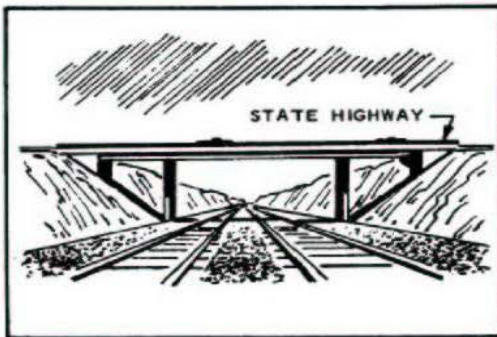
Naming Conventions

For structure type definitions see Section H.06 of this chapter.

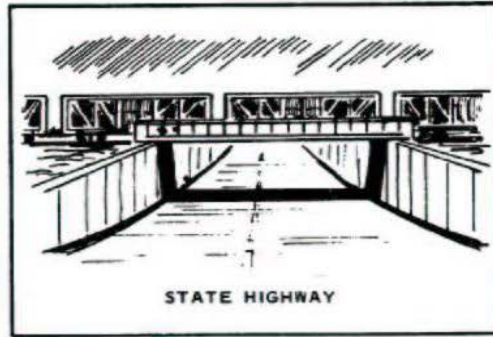
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BRIDGE



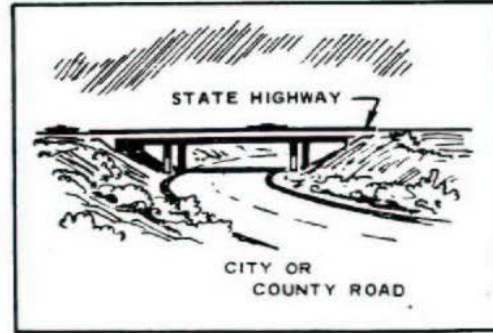
OVERHEAD



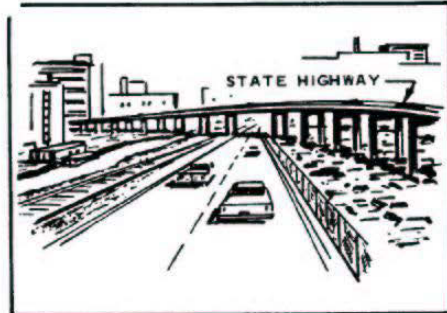
UNDERPASS



OVERCROSSING



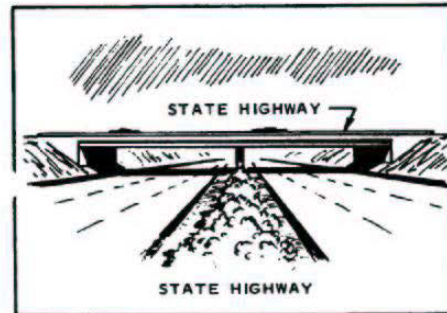
UNDERCROSSING



VIADUCT



VIADUCT



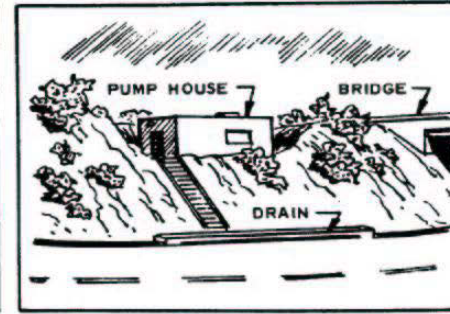
SEPARATION



TUNNEL



TUBE



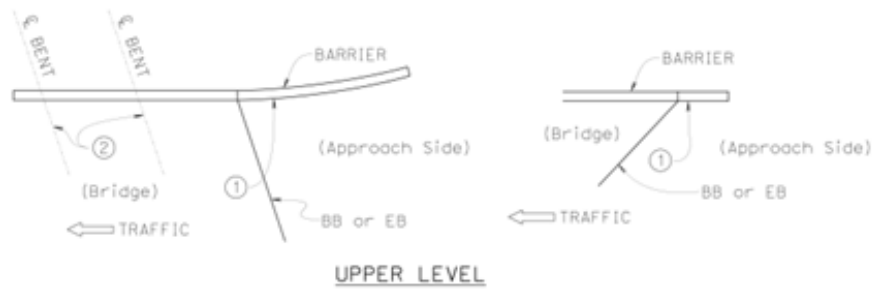
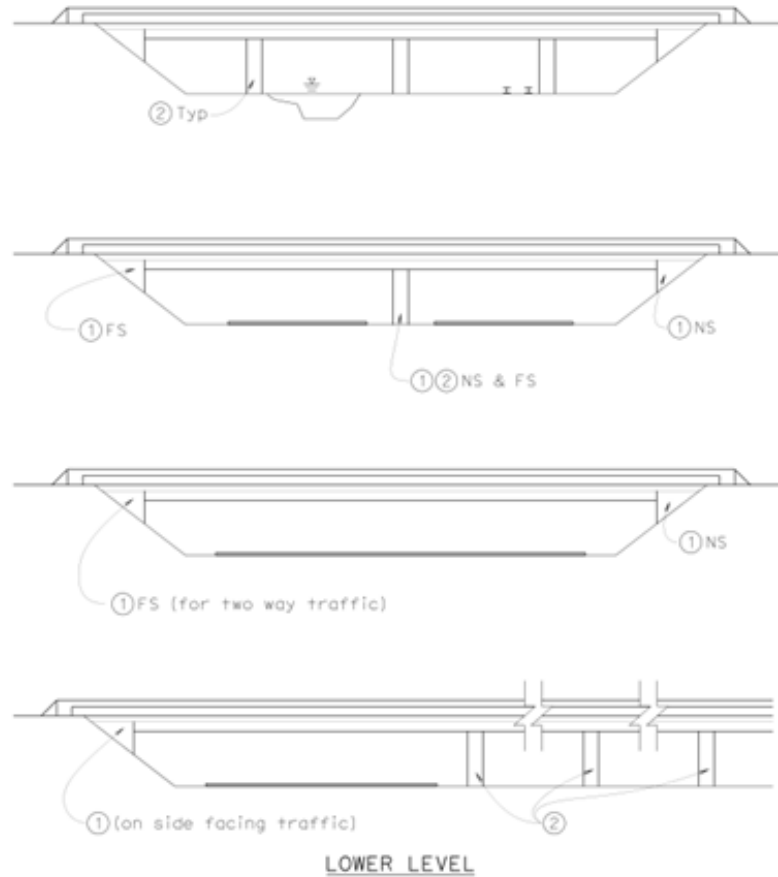
PUMP

APPENDIX H-2

Bridge Identification Locations and Structural Information

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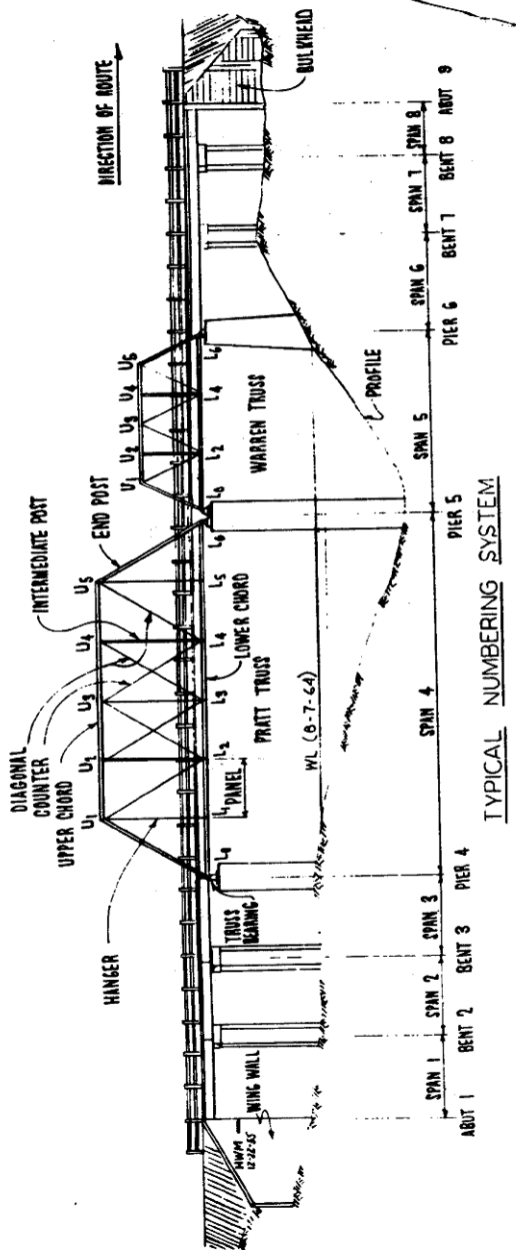
Location of Bridge Numbers, Names and Date Built



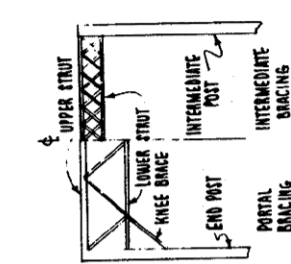
- ① Point "NAME OF STRUCTURE,
BRIDGE No. XX-XXXX"
Year Constructed
- ② Point Bent or Pier Number (on long structures only)

Structure Information:

BRIDGES



TYPICAL NUMBERING SYSTEM



TYPICAL SWAY FRAMING



DETAILS OF TRUSS AND FLOOR SYSTEM











TYPICAL TIMBER BENT

ABBREVIATIONS

- | | | | |
|-----|--|-----|---------------------------|
| RC | REINFORCED CONCRETE | WS | WEARING SURFACE |
| RW | REDWOOD | WL | WATER LEVEL |
| UF | UNTREATED FIR | HWM | HIGH WATER MARK |
| BTF | BROWN TREATED FIR (WOOD PRESERVATIVE) | VC | VERTICAL CLEARANCE |
| CDP | CROSSGRAINED DOUGLASS FIR (PRESERVE TREATED) | b/c | DISTANCE BACK TO BACK |
| | | c/c | DISTANCE CENTER TO CENTER |

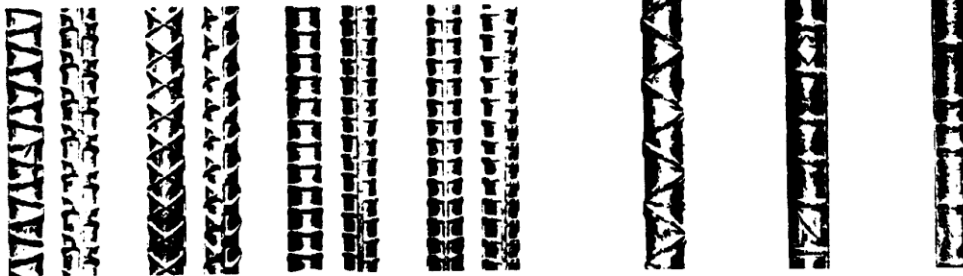
BRIDGES

REINFORCING STEEL BAR SIZES AND DIMENSIONS

| REINFORCING STEEL | | | | | |
|---|--------------------------|-------------------------------------|--|--|-----------------------------|
| STANDARD A305 REINFORCING BARS | | | | | |
| BAR SIZES | | WEIGHT POUNDS PER FOOT | NOMINAL DIMENSIONS — ROUND SECTIONS | | |
| OLD (INCHES) | NEW (NUMBERS) | | DIAMETER INCHES | CROSS SECTIONAL AREA - SQ. INCHES | PERIMETER INCHES |
|  | 2 | .167 | .250 | .05 | .786 |
|  | 3 | .376 | .375 | .11 | 1.178 |
|  | 4 | .668 | .500 | .20 | 1.571 |
|  | 5 | 1.043 | .625 | .31 | 1.963 |
|  | 6 | 1.502 | .750 | .44 | 2.356 |
|  | 7 | 2.044 | .875 | .60 | 2.749 |
|  | 8 | 2.670 | 1.000 | .79 | 3.142 |
|  | 9 | 3.400 | 1.128 | 1.00 | 3.544 |
|  | 10 | 4.303 | 1.270 | 1.27 | 3.990 |
|  | 11 | 5.313 | 1.410 | 1.56 | 4.430 |
| | 14 | 7.650 | 1.692 | 2.25 | 5.316 |
| | 18 | 13.600 | 2.256 | 4.00 | 7.088 |

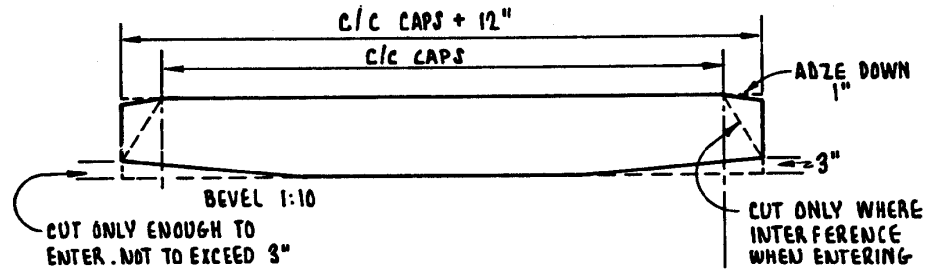
New Type Deformed Bars

Old Type Deformed Bars

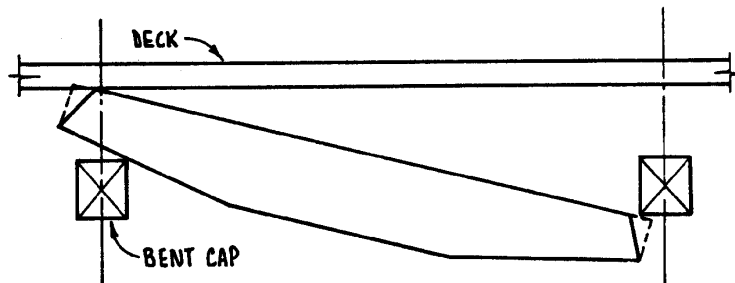


BRIDGES

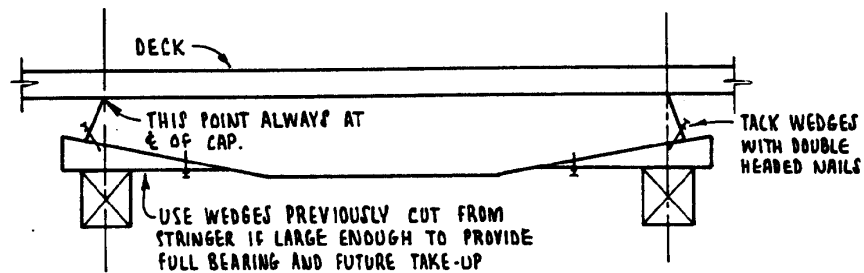
METHOD OF REPLACING EXISTING STRINGERS



CUTS TO BE MADE



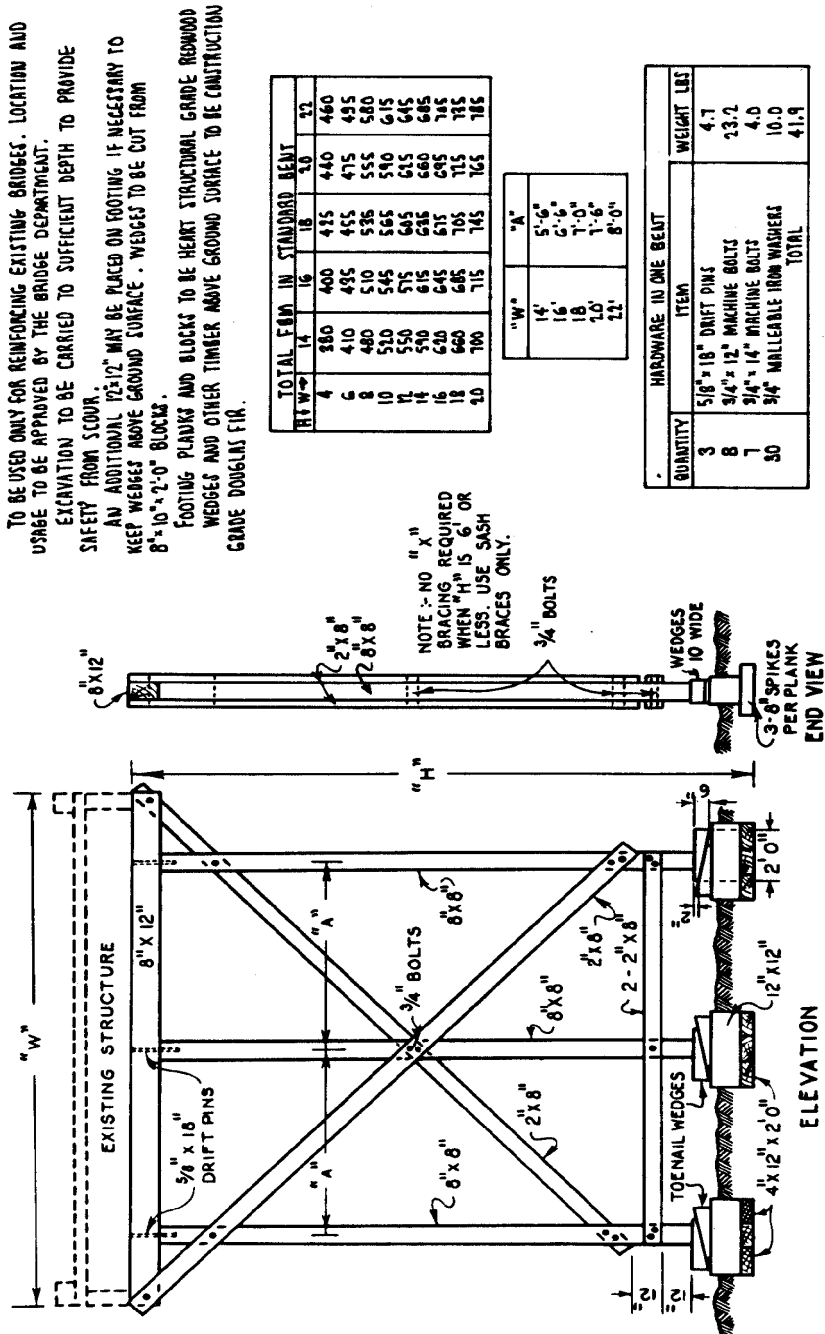
ENTERING STRINGER



WEDGED IN PLACE

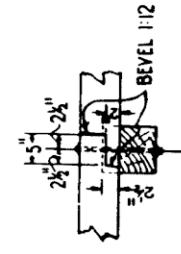
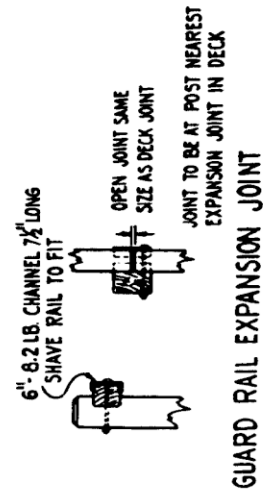
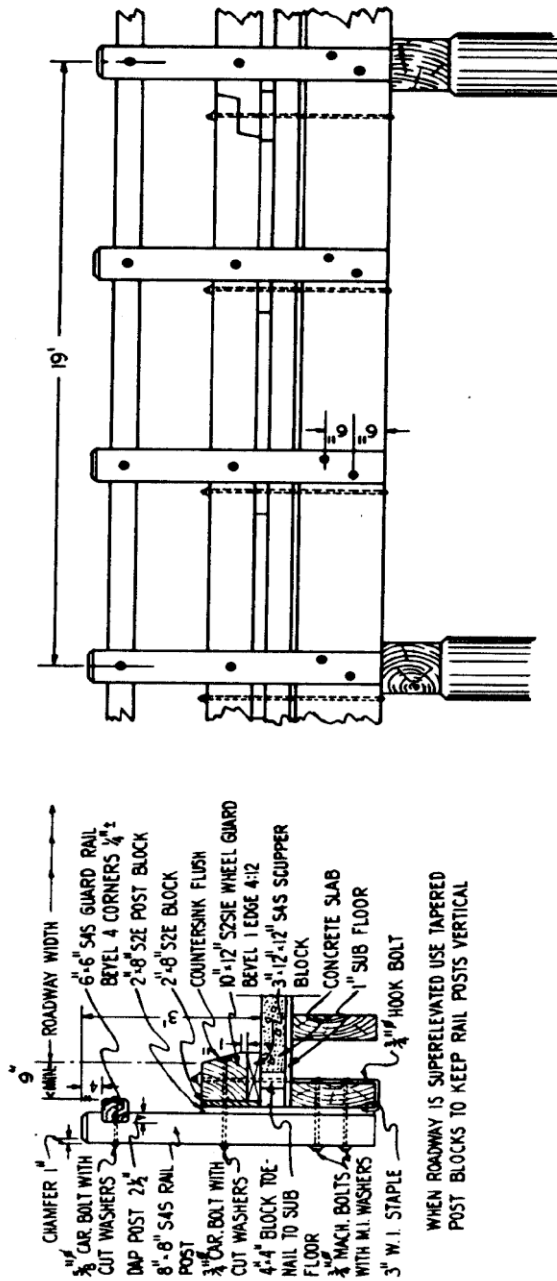
BRIDGES

DETAIL OF SUPPLEMENTAL TIMBER BENT



BRIDGES

STANDARD TIMBER GUARD RAIL AND WHEEL GUARD



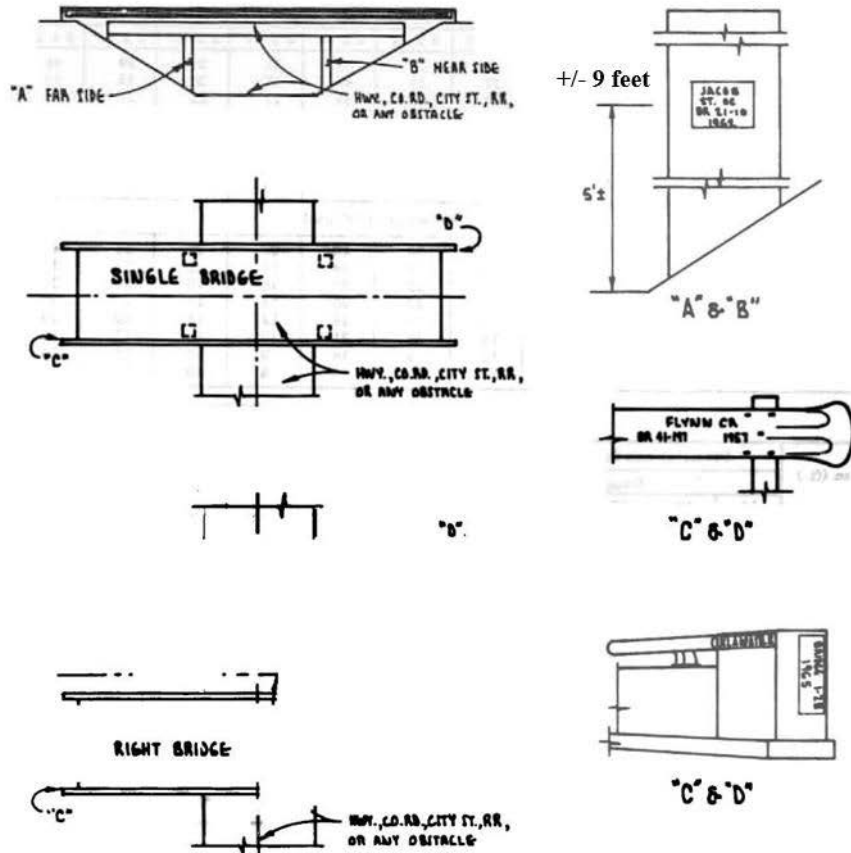
NOTE : ALL HARDWARE TO BE GALVANIZED
ALL TIMBER TO BE HEAT STRUCTURAL GRADE REDWOOD.

Dec-1989

BRIDGES

H-22

NAME, BRIDGE NUMBER, YEAR BUILT ON STRUCTURES



LOCATIONS

TYPICAL DETAILS

| STRUCTURE FUNCTION | DATA TO BE PLACED ON STRUCTURE | | |
|--------------------|--------------------------------|------------|------------|
| | NAME | BRIDGE NO. | YEAR BUILT |
| HWY OVER STREAM | C, D | C, D | C, D |
| HWY OVER CO. RD. | C, D | A, B, C, D | A, B, C, D |
| HWY OVER CITY ST. | C, D | A, B, C, D | A, B, C, D |
| HWY OVER HWY | A, B, C, D | A, B, C, D | A, B, C, D |
| HWY OVER RR. | C, D | C, D | C, D |
| HWY OVER OBSTACLE | C, D | C, D | C, D |
| HWY UNDER CO. RD. | A, B | A, B, C, D | A, B, C, D |
| HWY UNDER CITY ST. | A, B | A, B, C, D | A, B, C, D |
| HWY UNDER RR. | A, B | A, B | A, B |
| HWY UNDER OBSTACLE | A, B | A, B | A, B |

APPENDIX H-3

Notice of Change in Clearance or Bridge Weight Rating

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Lock Data on Form

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
NOTICE OF CHANGE IN CLEARANCE OR BRIDGE WEIGHT RATING

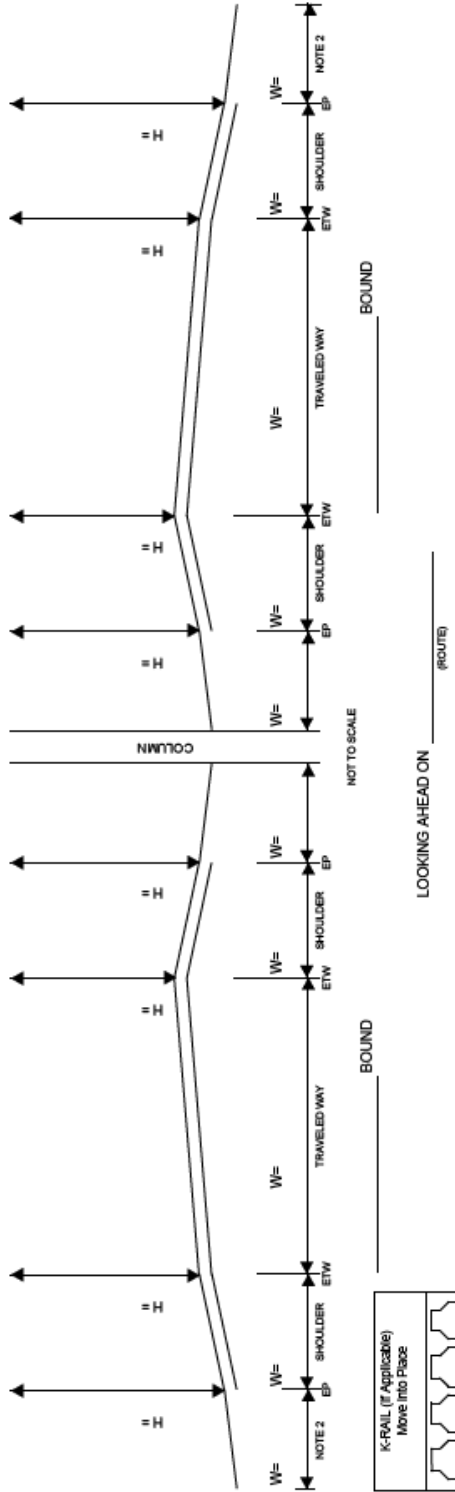
TR-0019 (REV 11/2014)

PLEASE SUBMIT THIS FORM TO: CONSTRUCTION/MAINTENANCE LIAISON PHONE (916-322-4957) FAX (916-322-4081) EMAIL (LIAISON.PERMITS@DOT.CA.GOV)

| | | | | | |
|--|--------|-------------------------------|----|--------------------------|------|
| BRIDGE NAME | | BRIDGE NUMBER | | DATE | |
| DISTRICT | COUNTY | ROUTE | PM | EA | CITY |
| SUBMITTED BY | | PHONE NUMBER | | FAX NUMBER | |
| TYPE OF CHANGE (SELECT ONE) | | TENTATIVE START DATE | | TENTATIVE END DATE | |
| <input type="checkbox"/> PERMANENT <input type="checkbox"/> TEMPORARY (SEE NOTE 1) | | | | | |
| BRIDGE WEIGHT RATING CHANGE (SELECT ONE) | | EXISTING BRIDGE WEIGHT RATING | | NEW BRIDGE WEIGHT RATING | |
| <input type="checkbox"/> YES <input type="checkbox"/> NO | | | | | |

CLEARANCE DIAGRAM

BRIDGE NAME _____



- NOTES:
- 1) FOR TEMPORARY VERTICAL CLEARANCE CHANGES, DIMENSIONS ARE TO BOTTOM OF FALSEWORK
 - 2) INCLUDE DISTANCE TO ANY OBSTRUCTION (i.e., GUARDRAIL, COLUMNS, K-RAIL)

| | | |
|---|------------------------|-------------------|
| FOR LIAISON USE ONLY: DATE RECEIVED BY LIAISON | DATE OF ROD/TRD CHANGE | LIAISON SIGNATURE |
|---|------------------------|-------------------|

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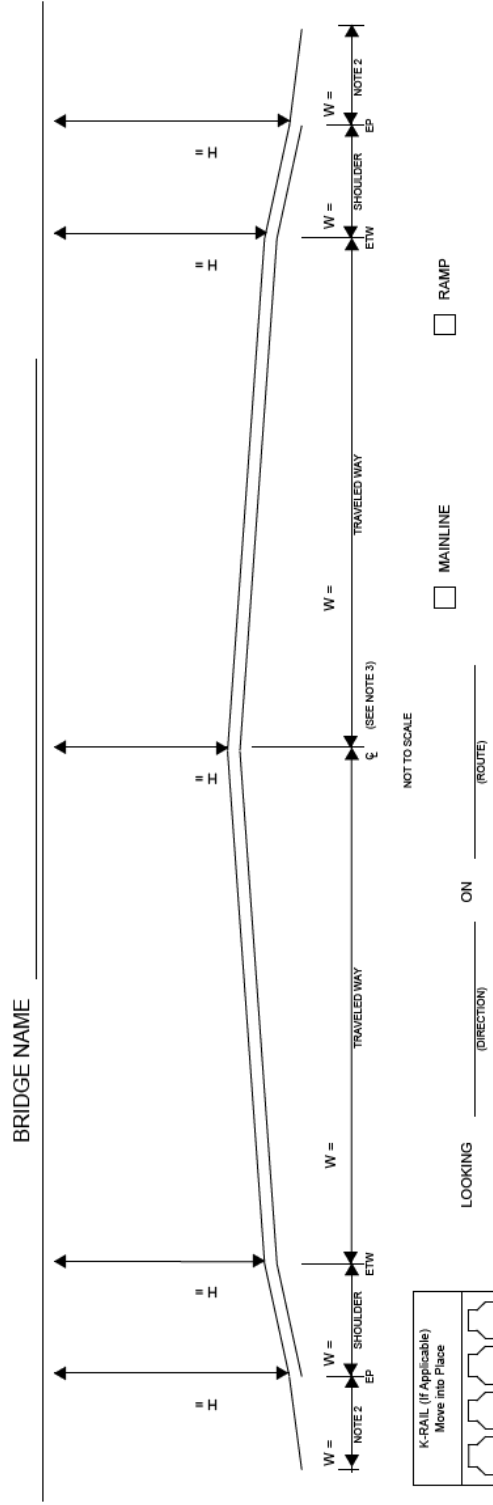
Lock Data on Form

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
NOTICE OF CHANGE IN CLEARANCE OR BRIDGE WEIGHT RATING
TR-0029 (REV 11/2014)

PLEASE SUBMIT THIS FORM TO: CONSTRUCTION/MAINTENANCE LIAISON PHONE (916-322-4957) FAX (916-322-4081) EMAIL (LIAISON.PERMITS@DOT.CA.GOV)

| | | | | | |
|--|--------|-------------------------------|----|--------------------------|------|
| BRIDGE NAME | | BRIDGE NUMBER | | DATE | |
| DISTRICT | COUNTY | ROUTE | PM | EA | CITY |
| SUBMITTED BY | | PHONE NUMBER | | FAX NUMBER | |
| TYPE OF CHANGE (SELECT ONE) | | TENTATIVE START DATE | | TENTATIVE END DATE | |
| <input type="checkbox"/> PERMANENT <input type="checkbox"/> TEMPORARY (SEE NOTE 1) | | | | | |
| BRIDGE WEIGHT RATING CHANGE (SELECT ONE) | | EXISTING BRIDGE WEIGHT RATING | | NEW BRIDGE WEIGHT RATING | |
| <input type="checkbox"/> YES <input type="checkbox"/> NO | | | | | |

CLEARANCE DIAGRAM



- NOTES:
- 1) FOR TEMPORARY VERTICAL CLEARANCE CHANGES, DIMENSIONS ARE TO BOTTOM OF FALSEWORK
 - 2) INCLUDE DISTANCE TO ANY OBSTRUCTION (i.e., GUARDRAIL, COLUMNS, K-RAIL)
 - 3) FOR DIVIDED HIGHWAYS, USE FORM NUMBER TR-0019

FOR LIAISON USE ONLY:

DATE RECEIVED BY LIAISON _____ DATE OF RCD/TRD CHANGE _____

LIAISON SIGNATURE _____

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APPENDIX H-4

Notice of Change in Vertical or Horizontal Clearance

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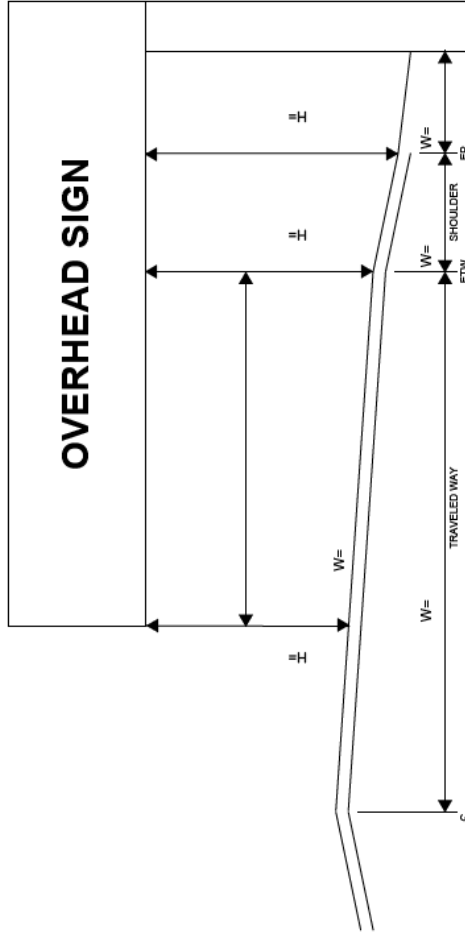
Lock Data on Form

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
NOTICE OF CHANGE IN VERTICAL OR HORIZONTAL CLEARANCE
TR-0020 (REV 11/2014)

PLEASE SUBMIT THIS FORM TO: CONSTRUCTION/MAINTENANCE LIAISON PHONE (916-322-4957) FAX (916-322-4081) EMAIL (LIAISON.PERMITS@DOI.CA.GOV)

| | | | | | |
|--------------|--------|--------------|----|------------|------|
| SIGN NAME | | SIGN NUMBER | | DATE | |
| DISTRICT | COUNTY | ROUTE | PM | EA | CITY |
| SUBMITTED BY | | PHONE NUMBER | | FAX NUMBER | |

CLEARANCE DIAGRAM



NOT TO SCALE

LOOKING _____ (DIRECTION) _____ ON _____ (ROUTE)

MAINLINE RAMP

| | | |
|---|------------------------|-------------------|
| FOR LIAISON USE ONLY: DATE RECEIVED BY LIAISON | DATE OF RCD/TRD CHANGE | LIAISON SIGNATURE |
|---|------------------------|-------------------|

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